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SURFACE HARDENING TREATMENT METHOD FOR COMPONENT DEEP HOLES IN A VACUUM FURNACE
[SINKUURO NIOKERU BUHIN FUKAANA NO HOUMEN KOUKASHORIHOUHOU]

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[Scope of the Claims]

[Claim 1] A surface hardening treatment method for component deep holes that is characterized by metal finishing treatment equipment wherein the atmosphere within a furnace, such as a vacuum furnace, is controlled, and is established within a furnace that is maintained at a set temperature, processing gas is supplied for deep holes as of components which are the subject of surface treatment, the atmosphere within a furnace is exhausted such as maintaining a set pressure, and gas decomposition and osmosis dispersion treatment for deep hole interior are performed by maintaining contact of a process gas and the hole inner walls under required conductions by generating a convection current of treatment gas that is supplied within the deep holes.

[Claim 2] A surface hardening treatment method for component deep holes as claimed in Claim 1 that is characterized by the abovementioned surface treatment being carburization, carburization nitriding, soft nitriding, or gas nitriding treatment.

[Claim 3] A surface hardening treatment method for component deep holes as claimed in Claim 1 or Claim 2 that is characterized by the shape of the abovementioned deep holes being an irregular shape such as a straight hole, curved hole, non-through hole, through hole or manifold.

[Detailed Explanation of the Invention]

[0001]

[Industrial Field of Application] The present invention pertains to a surface hardening treatment of component deep holes, and especially has an objective of executing a surface hardening treatment for component deep holes in a vacuum furnace.

[0002]

[Prior Art] Hardening effects which are required for deep hole components cannot be obtained when the aspect ratio (Aspect ratio = hole depth/hole diameter) of the inner holes is comparatively large in cases of performing surface hardening treatment of steel material inner holes in a prior manufacturing process.

[0003]

[Problems to be Solved by the Invention] Exhaust gas and exhaust salts and such require reprocessing due to air or salting in being used as a heating material in prior furnaces. Further, the problem of oxidation is serious at high temperatures, but these problems are solved due to requiring operation by humans.

[0004]

[Means for Solving the Problems] The present invention offers a surface hardening method that is utilized by vacuum furnaces. Vacuum furnaces have a high cost, but the reproducibility is high and automation is simple, thus large scale production is possible. In the present invention, first, components, gas transport tube and fixed apparatus are washed and dried, then established suitably near in a heating space within a vacuum furnace. Then, the pressure is decreased in the heating space of the vacuum furnace then heated to a processing temperature. The treatment gas is continuously sent to the deep holes with a transport tube in a suitable flow rate with the pressure slightly higher than the pressure of the heating space. The vacuum space is maintained at a set low pressure state with a vacuum pump, the treatment gas is inevitably forcibly exhausted from the inner hole wall to outside the hole, simultaneously decomposed, and permeated and dispersed toward the hole wall. [This] is maintained for a suitable time in order to

obtain an adequate carburization depth. Finally, treatments are performed like cooling of the components with carburization or carburization nitriding processing being performed, and the required hardened layer is obtained. A treatment method of the present invention can be commercially utilized, and the effects can be improved on a large scale.

[0005]

[Embodiments of the Present Invention] The present invention solves the problem of the gas, which performs the treatments of carburization, nitriding, soft nitriding and carburization nitriding, being difficult to cause to flow into deep holes due to the forcible flow by gas which performs carburization, nitriding or soft nitriding or carburization nitriding and such, entering into component deep holes with a tube in a vacuum furnace. Surface hardening treatments like effective carburization, nitriding, soft nitriding and carburization nitriding can be performed in all of the various forms like non-through hole, through hole and curved hole (including branched inner holes).

[0006] A concrete carburization example is shown below for clarification of the technological content of the present invention. As shown in Figure 1, first, component 90 (JIS SCM415, outer diameter [phi]16 X 120 L, inner diameter [phi]3 X 100 L) with 1 non-through hole, gas transport tube 40 and fixed apparatus 30 are washed and dried, then established in a suitable position of heating space 20 of vacuum furnace 10. Then, the pressure is decreased in heating space 20 by removing the air from the gas exhaust part 11 with a vacuum pump, then heated to a treatment temperature (950 ~ 1,000°C). Also, the treatment gas (acetylene gas) of slightly higher pressure than the heating space and a suitable flow rate (0.21/min) is continuously sent from transport tube 40 to the deep holes of component 90. The pressure of the heating space is increased to 5 ~ 6 from the

gassing inlet 12 by the "ON/OFF" control valve. The heating space 20 is maintained at the established low pressure state by removing the gas utilizing a vacuum pump, thus treatment gas forcibly flows from the hole walls of the inner holes to outside the holes and is simultaneously decomposed within the holes, and is permeated and dispersed toward the hole walls. A suitable time (approximately 15 ~ 30 minutes) and temperature is maintained after stabilization by this means, and an adequate carburization depth is obtained. Immediately afterward, the required hardened layer is obtained by cooling after again heating the carburized component 90 to 860°C. The result of the hardness analysis was that an obtained uniform adequate hardened depth was possible with a hardness layer of an inner diameter individual position higher than a hardened layer of an outer diameter. A completely uniform deep hole hardening depth can be obtained according to the length of the carburization time since the relationship of the maximum hardened depth and the carburization time coincides with the principle of dispersion.

[0007]

[Effect of the Invention] According to the present invention, treatment gas is sent into the component inner holes by a transport tube by a vacuum heat treatment technology, the treatment gas forcibly flows due to the decreased pressure of vacuum treatment space, and surface hardening treatment like carburization, nitriding, soft nitriding, carburization nitriding can be performed for a straight hole (including through holes and non-through holes), curved holes and manifolds at a suitable treatment temperature. The present invention has a high reproducibility and simple automation.

[Simple Explanation of the Figures]

[Figure 1] is a cross-sectional explanatory diagram of executing a surface hardening treatment for a component that has non-through holes

[Figure 2] is a cross-sectional explanatory diagram of executing a surface hardening treatment for components that have through holes

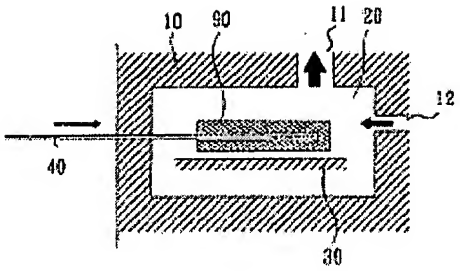
[Figure 3] is a cross-sectional explanatory diagram of executing a surface hardening treatment for components that have bent holes

[Explanation of the Symbols]

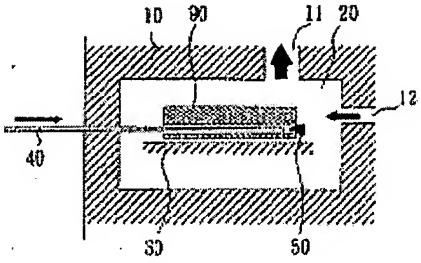
/3

(10)	vacuum furnace	(40)	gas transport tube
(11)	gas exhaust	(50)	unit
(12)	gas inlet	(60)	heat resistant airtight material
(20)	fixed apparatus	(90)	component
(30)	fixed apparatus		

[Figure 1]



[Figure 2]



[Figure 3]